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PROTECTING PONDEROSA PINE FROM BARK BEETLE ATTACK BY USE OF A LINDANE-WATER EMULSION SPRAY

By

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INTRODUCTION

Bark beetles are the primary killer of trees in the timber stands of California. Logging infested trees or treating them with lindane are satisfactory suppression methods used in commercial timber stands. On recreation lands, where each individual tree may have a high aesthetic value, this type of control is not always sufficient. A partial solution to the problem is the prevention of bark beetle attack through the application of a protective spray to selected standing live trees.

Limited tests in Region 5 indicate that a lindane insecticide applied to standing live trees is effective as a protective spray (1, 2, 3). 1/ The main problem has been to find a suitable method of applying an insecticide high enough on the bole of tall trees to afford adequate protection. Bark beetles commonly attack above the portion of the bole that can be sprayed by a man standing on the ground. Application of insecticide by helicopter was unsuccessful (4).

The objective of this study was to determine the feasibility and effectiveness of applying a protective spray from a boom truck as well as testing the effectiveness of lindane-water emulsion as a protective spray.

RECENT HISTORY OF THE STUDY AREA

In 1961, a western pine beetle (Dendroctonus brevicomis Lec.) outbreak developed in an isolated 250-acre ponderosa pine stand at Ranger Peak on the Santa Maria District of the Los Padres National Forest. The average elevation is 4,000 feet with site II growing conditions prevailing generally throughout the area. The bark beetle outbreak was controlled by falling and treating the infested trees with a 1.5 percent lindane-oil spray but not until 35 percent of the stand volume was killed (5).

1/ Numbers in parentheses refer to Literature Cited, page 13.

In July 1963, a fire swept through the same area killing some of the remaining trees and damaging a majority of others. A buildup of the red turpentine beetle (Dendroctonus valens Lec.) occurred soon after the fire, followed by another outbreak of the western pine beetle and the California five-spined engraver beetle (Ips confusus Lec.). Rather than attempt to control the existing infestation by treating infested trees, the Forest was advised to try to save selected trees from future bark beetle attacks by applying a preventive spray.

METHODS AND PROCEDURES

TREE CLASSIFICATION

Shortly after the July 1963 fire, all merchantable trees in the stand were examined. Using Wagener's guidelines, these trees were rated according to their chance of surviving the fire injury (6). The trees were placed into one of four classes ranging from uninjured or slightly injured to severely injured.

Class 1. Zero to light crown or cambium damage.

Class 2. 50 percent or more live crown with zero to light cambium damage.

Class 3. Less than 50 percent live crown with zero to moderate cambium damage.

Class 4. Crown destroyed or combination of severe crown and cambium damage.

After examination and classification it appeared that most of the trees in classes 1 and 2 would survive the fire damage unless attacked by bark beetles, while most of the trees in classes 3 and 4 would die.

TEST TREE SELECTION

In the spring of 1964, 100 ponderosa pine in classes 1 and 2 were selected for bark beetle protection. The test trees were located in groups surrounded by or adjacent to numerous infested trees. Most of the selected trees were located on less than 15 percent slopes in order to be easily

accessible to a boom truck. Average tree height was approximately 100 feet with a range in height from 20 feet to 125 feet. The trees ranged in diameter from 14 inches to 48 inches, with an average diameter of 26 inches (figure 1). Each tree was plotted on a map and numbered with a metal tag.

CHECK TREES

In addition to the trees selected for spraying, all the class 1 and 2 trees (340) in the same area were marked as check trees.

SOURCE OF WESTERN PINE BEETLE

There were hundreds of class 3 and 4 trees in and around the test area to furnish a source of attractive host material. When these trees became infested, they yielded high bark beetle populations.

INSECTICIDE

A 20 percent lindane emulsifiable concentrate with 1.7 pounds of lindane per gallon of solvent was slected because of its high toxicity and relatively long residual life. Lindane in diesel oil is the standard Region 5 treatment for bark beetle infested trees. Since the test was designed to protect live trees, a water carrier was used as it would be less damaging to the foliage than an oil carrier.

The lindane spray was mixed at a ratio of 1 part concentrate to 15 parts water yielding 1.25 percent by weight (1.5 percent by volume) lindane spray. The spray material was mixed in a 100-gallon spray trailer with a built-in agitator. The mixed insecticide was then transferred to the pressure tank on the boom truck (figure 2).

After the lindane was thoroughtly mixed, samples were taken from alternate batches for chemical analysis. All of the samples tested at 1.3 percent lindane (by weight) or higher.

SPRAY EQUIPMENT AND TECHNIQUES

The trees were sprayed from a truck with a hydraulically operated 50-foot maneuverable boom (figure 3). The operator rode in a bucket on the distal end of the boom and maneuvered the boom with controls provided in the bucket (figure 4). The boom truck was equipped with hose and a pressurized spray tank. The boom truck was not operated on slopes steeper than 20 percent grade.

A pump pressure of between 90 to 100 pounds gave the best spray pattern. The operator used a spray wand with a 24-hole disc in the nozzle for coverage from 8 feet up to a height of 50 feet. A high-pressure wand with a solid stream was used to reach an additional height of 20 feet. When the wind velocity exceeded 8 m.p.h., spraying was stopped due to excessive drift.

A Forest Service employee checked the trees for spray coverage while the actual spraying was taking place, directing the operator to cover missed bark areas. Therefore, it was not necessary to use a dye to determine coverage.

After each tree had been sprayed, it was marked with red flagging. Forest Service personnel then sprayed the bottom 8 feet of the tree bole with a hand sprayer (figure 5).

Spray height on several trees was checked with an abney. These heights ranged from 50 feet to 75 feet with an average of 68 feet. During the second spraying, the high-pressure wand was not available and the average spray height dropped to 60 feet.

TIMING OF SPRAY APPLICATION

The most effective time to apply a protective insecticide against western pine beetle is in the spring just prior to emergence of the overwintering generation. The first spray treatment was in April 1964.

Since the western pine beetle has several generations a year, there was a question whether or not the residual life of a lindane-water emulsion would afford adequate protection with just one spray application. In earlier tests by Lyon, lindane in form of a wettable powder had a very short residual life as it crystallizes wholly as a surface deposit which breaks down in sunlight (7). No tests have been made to determine whether or not a lindane-water emulsion would yield a surface deposit or a tissue deposit which has a long residual life. Thus, in order to assure more complete protection, 84 of the selected trees were resprayed just prior to the emergence of the first generation. This second spray treatment was in July 1964, three months after the first treatment.

EVALUATION OF SPRAY EFFECTIVENESS

To determine the effectiveness of the protective spray, a comparison between the number of treated trees and untreated trees which were successfully attacked by the western pine beetle was made. Trees were

checked for mortality just prior to the second treatment, approximately three months after the second treatment, and one year after the first treatment.

TREE MORTALITY

When the sprayed trees were examined in June, two months after the first treatment, none had been successfully attacked by bark beetles. In the adjacent area, 273 class 3 and 4 trees were currently infested but only two of the class 1 and 2 check trees had been attacked. This indicated that bark beetle pressure was not sufficient to prove that the protective spray was effective since so few of the class 1 and 2 trees had been attacked.

In October, three months after the second treatment, eight of the sprayed trees were infested. One additional tree became infested two months later. There was no additional mortality in the treated trees when they were examined one year after the initial spray treatment.

The test trees and the check trees had been subjected to equal bark beetle pressures. In the adjacent area, 117 trees out of 340 class 1 and 2 check trees (34.4 percent) and all the class 3 and 4 trees were killed by bark beetles by the time of the October check.

TABLE 1 - MORTALITY SUMMARY (OCTOBER 1964)

TREE CLASS	SPRAYED TREES			CHECK TREES		
	Total Number	Number Infested	% Infested	Total Number	Number Infested	% Infested
CLASS 1	51	0	0	139	26	11.5
CLASS 2	49	9	18	201	91	45.3
TOTAL	100	9	9.0	340	117	34.4

HEIGHT OF BARK BEETLE ATTACK

The nine sprayed trees killed by bark beetles were felled during the following winter and the height of attack on each tree was measured. Except for one tree which had red turpentine beetle attacks in the butt, all successful bark beetle attacks were apparently above the upper limits of the sprayed portion of the bole indicating that the lindane formed a tissue deposit and successfully protected that portion of the tree properly treated with the spray. The lowest invasion of the bark beetles was 57 feet above the ground, Table II. Often the majority of successful western pine beetle attacks are below this height. The cambium remained green under the sprayed bark surface.

TABLE II - INFESTED TREE SUMMARY (SPRAYED)

Tree No.	Class	Height Free of Attack (Ft.)	Insects
15	2	72	Ips
16	2	66	D.b., Ips
17	2	66	D.b., Ips
18	2	60	D.b., Ips
20	2	57	D.b.
23	2	66	D.b.
24	2	60	M.c., Ips, D.v.
25	2	60	M.c., Ips
62	2	63	D.b.

CATCHMENT NETS

At the time of the first treatment, cheesecloth catchment nets were constructed around the base of five sprayed trees to catch dead or dying insects falling from the bole of the tree (figure 6). Collections made from these nets showed the variety and number of insects contacting the sprayed bark and presumably dying from contact with the lindane.

The largest number of insects were collected in the net located at tree number 14 in the area where the greatest number of infested trees were located. The nets containing the greatest number of bark beetles also had the largest number of predators. A total of 316 bark beetles and predators were collected over a 3-month period indicating that lindane and water spray must have a surface deposit.

TABLE III - NUMBER OF BARK BEETLES AND PREDATORS COLLECTED FROM CATCHMENT NETS

INSECT	CATCHMENT NET (TREE) NUMBER: 2	14	57	72	91	TOTALS
Dendroctonus brevicomis	15	114	15	18	8	170
Dendroctonus valens	-	2	1	1	-	4
Ips spp.	-	11	5	1	-	17
Temnochila virescens	1	10	1	1	2	15
Enoclerus lecontei	7	52	3	43	5	110
TOTALS	23	189	25	64	15	316

COSTS AND EFFICIENCY

Cost figures accumulated during the project show that the first treatment cost $18.05 per tree and the second treatment cost $16.60 per tree. These costs are less than the cost to fall and treat infested trees in the same area. In the period January-June 1963, the average cost for treating infested trees at Ranger Peak was $25.00 per tree.

A boom truck with operator was contracted at $20.00 per hour. The cost of applying a protective spray with a boom truck would probably be less than reported here if this method were used more frequently. The spray operators became more efficient as the spraying progressed. They took less application time and used fewer gallons per tree toward the end of the project than at the beginning. This indicates that with more experience the cost per tree would drop considerably. The following tables summarize the pertinent cost and efficiency data.

TABLE IV - COST SUMMARY

Treatment	No. of Tree Treatment	Insecticide Cost	Contract Cost	Force Account Cost	Total Cost	Av. Cost Per Tree Treatment
First	103[1/]	$510.00	$ 960.00	$389.00	$1,859.00	$18.05
Second	84	354.00	820.00	220.00	1,349.00	16.60
TOTAL	187	$864.00	$1,780.00	$609.00	$3,208.00	$17.16

TABLE V - TREATMENT EFFICIENCY SUMMARY

Days	FIRST TREATMENT[2/] No. of Trees	Av. Gals. Insecticide Per Tree	Av. Time Per Tree (Minutes)	SECOND TREATMENT No. of Trees	Av. Gals. Insecticide Per Tree	Av. Time Per Tree (Minutes)
First Day	20	20	25.0	14	12	28.0
Remaining Days	83[1/]	12	16.5	70	8	16.0
Average	-	13	18.0	-	9	18.0

1/ Three trees #87, 88, and 89 were isolated and not subject to the same bark beetle pressures as the other sprayed trees. These three trees were eliminated from the test and only considered in the cost and efficiency data.

2/ The contractor sprayed an average of 10 feet higher on the first treatment than the second treatment because the high pressure spray wand was not available for the second treatment.

CONCLUSIONS

Nine of the 100 sprayed trees were killed by the western pine beetle. Two had been sprayed once and seven had been sprayed twice. However, none of these trees were attacked in the sprayed portion of the bole. No apparent difference in protection between trees that had been sprayed once or twice was observed. Thus, one application of a 1.25 percent (by weight) lindane-water emulsion spray, if applied prior to the time of the overwintering brood emergence, will give satisfactory protection from western pine beetle attack on the sprayed portion of the bole during the active bark beetle period (spring through fall).

Insects were collected in catchment nets for a period of three months indicating that a lindane-water emulsion spray will form a surface deposit. However, it is known that decomposition of lindane deposits is quite rapid in sunlight (8). Since the trees were not attacked within the sprayed portion of the bole for a seven-month period, this proved that a lindane-water emulsion spray also forms a tissue deposit. Such a tissue deposit has a long residual life which is necessary for a successful protective spray.

This treatment, using a boom truck, is practical and economical in recreation and other developed areas of relatively flat terrain. In stands where trees are under 50 feet in height, conventional ground sprayers may reach high enough to give adequate protection.

The cost per tree of protecting trees from attack was less than the cost per tree of treating infested trees. The land manager has the advantage of selecting the trees to be protected rather than spend money on treating trees which are already dead.

In high-value recreation areas, an effective method is now available for preventing tree losses due to bark beetles.

Fig. 1. Typical size trees which were sprayed by boom-truck sprayer.

Fig. 2. Mixing and loading insecticide.

Fig. 3. Contract boom-truck spraying operations.

Fig. 4. Close-up of contract operator spraying from bucket.

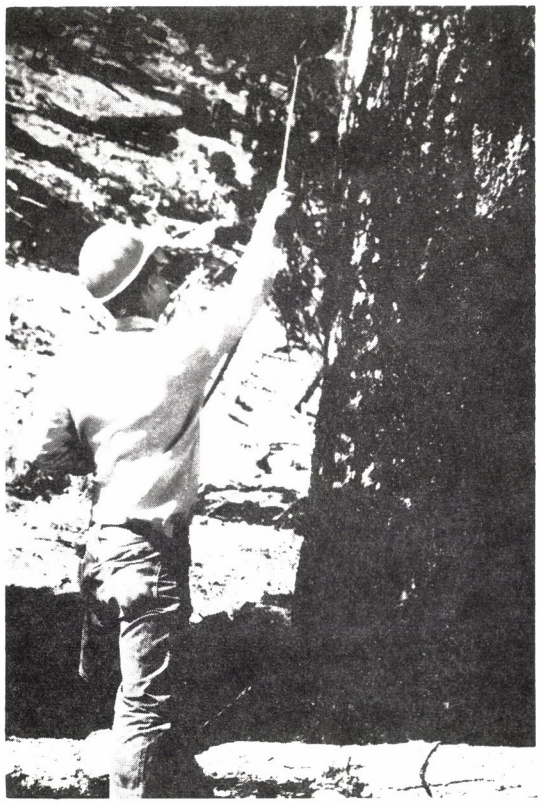

Fig. 5. Spraying tree butt with hand sprayer.

Fig. 6. Catchment net at base of test tree.

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